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חוק הפטנטים, התשכ"ז-1967
PATENTS LAW, 1967-5727

בקשה לפטנט
PATENT APPLICATION

אני, (שם המבקש, מענו - ולגבי גוף מאוגד - מקום התאגדותו)
I (Name and address of applicant, and, in case of body corporate, place of incorporation)

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בעל אמצאה מכח___היותו הממציא___ששמה הוא:
Owner, by virtue of being the inventor of an invention, the title of which is:

(בעברית) (Hebrew) שיטה למציאת קצב לב

(באנגלית) (English) **Method for determining heart rate**

hereby apply for a patent to be granted to me in respect thereof. מבקש בזאת כי ינתן לי עליה פטנט.

*בקשת חלוקה- Application for Division	*בקשת פטנט מוסף- Application for Patent of Addition	*דרישת דין קדימה **Priority Claim**		
מבקשת פטנט **from application**	לבקשה/לפטנט to Patent/Appl.	מספר/סימן **Number/Mark**	תאריך **Date**	מדינת האיגוד **Convention Country**
No_____ מס'	No_____ מס'			
dated_____ מיום	dated_____ מיום			

*יפוי כח: כללי/מיוחד - רצוף בזה / עוד יוגש
P.O.A.: general / specific - attached / to be filed later-

Has been filed in case_____ הוגש בענין

המען למסירת הודעות ומסמכים בישראל
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חתימת המבקש
Signature of Applicant

היום This 10 | בחודש of February פברואר | שנת of the year 2004

REFERENCE: סימוכין:

טופס זה,כשהוא מוטבע בחותם לשכת הפטנטים ומושלם במספר ובתאריך ההגשה, הינו אישור להגשת הבקשה שפרטיה רשומים לעיל

Invention Description for Patent Application

Method for determining heart rate

Inventor: **Itshak Y. Ben Yesha**

Method for determining heart rate

Disclosed is a system, apparatus and method for the detection of vital signs, whose novelty is the method for determining heart rate.

Basic to the system of the present invention is an array of at least two pressure-sensitive transducers/gages ("sensors") located under the patient's body, supporting its weight. Summing the signals of all sensors results in a combined signal corresponding to vertical movements of the body, mainly respiratory movements, and to vertical environmental "noise", mainly the product of a vibrating floor. We will call this sum of signals "**The Vertical Signal**".

Deducting of said signals or signal groups from each other results in a combined signal corresponding to horizontal movements of the body's center of gravity, mainly due to blood circulation and movements of body limbs.
We will call this difference of signals "**The Horizontal Signal**".

In order to determine heart rate, the signals to be **deducted** from each other are those corresponding to the head side and the foot side of the patient. This is because the blood's center of gravity driven by the heart, moves along the body's axis. The name **"Axial Signal"** describes the difference between the head side signal and foot side signal, which is the Horizontal Signal when measured along the body axis. The determination of the Axial Signal is a crucial first step for heart rate determination.

When the major position of the patient is stationary (as with adult people in a hospital bed, or a baby in a small crib) the best solution will include two sensors whose connecting line is parallel to the body's axis, or two groups of sensors – a group at the head side, and another at the foot side. The combined signals of the two groups will be deducted from each other to determine the Axial Signal.

When the patient is expected to change the body axis' direction, like a baby in a bed or a pet in a cradle, the best solution will consist an array of at least 3 sensors. Since the body axis is not known, the deduction will be made by mathematically determining the maximum difference of signal within each pair of sensors. This maximal difference is the Axial Signal.

The second step is by using the peeks of the Axial Signal to determine heart rate.

Best solution will be achieved by filtering, normalizing and comparing Vertical and Axial Signals. This will enable an accurate heart rate and respiration rate determination, while rejecting limb movements and mutual artifacts.
Filtering signals in order to determine heart rate should be done using **high-pass filter whose frequency is at least twice** the monitored patient's typical heart frequency. (contrary to the failed efforts known to determine heart rate using high-pass filter whose frequency is lower than the heart rate).

Using low-pass filter whose frequency is at least 6 times the typical heart rate will help to reduce noise.

The best way to build the system is combining the new heart-rate determining technology, with the existing respiratory monitoring technology:

See drawing no 1-

A sensor pad (1) consisting two solid boards, between them an array of 4 pressure sensitive elements (sensors) (3). The pad is located under the mattress of the patient.
A cable connects all 4 sensors to the control and processing unit (CPU) (2).
The PCU processes all 4 input signals, computing the Axial Signal and the Vertical Signal in accordance with the method described above. Then using filters to isolate heart-beats' and respirations' artifacts from noise and from each other. Both cyclical vital signs are measured and displayed. Another algorithm whose inputs are the heart rate and respiration rate is used to trigger an alarm system, which is an integral part of the CPU.

Patent
Ben Yesha

Method for determining heart rate

Drawing No. 1

(1) Sensor Pad
(2) CPU
(3) Pressure Sensitive Elements